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STATISTICAL ANALYSIS OF RECENT FAULT-PLANE SOLUTIONS OF EARTHQUAKES

By A. E. Scheidegger

ABSTRACT

The large number of fault-plane solutions at present available in the literature permit one to calculate several statistical averages that have an important bearing upon geotectonics. The present paper represents a continuation of earlier work in this direction: 101 new fault-plane solutions are listed and the ratio of pressure to tension, strike slip to dip slip, and the average slip angle have been calculated for nine earthquake areas. Some of the older results are thereby corroborated, viz., that the "normal" character of earthquakes is to represent strike-slip faulting, and that the central Asian regions constitute an exception to this rule. In addition, it is now possible to make a breakdown with regard to depth. In this, a peculiar situation is found at 0.03 R depth, where the slip angle reaches a maximum. If the relationship between shallow and deep earthquakes be considered for any one area, however, it turns out that they are on the whole of the same character. Thus, whatever it is that causes earthquakes, acts in a similar fashion at all depths in any one area, but differs from one area to another.

Introduction

One body of seismological data that has rapidly been accumulating in recent times concerns fault-plane solutions of earthquakes. These fault-plane solutions are concerned with a determination of the position of the fault plane and of the motion direction in the focus of a seismic shock. In general, the fault plane is given by its dip and dip direction, and the motion direction is given by the dip and dip direction of the plane normal to it (the "auxiliary" plane). The nature of the seismological evidence is such that it is often not possible to decide which is the fault plane and which is the auxiliary plane.

If the fault planes are plotted on a map of the region in which a series of earthquakes occurred, it is usually not possible to discern any orderly pattern. It appears that the way in which a particular earthquake occurs is mostly due to chance, and that only certain statistical averages have any significance with regard to questions of tectonics. The writer has attempted on a previous occasion to deduce significant statistical averages from the body of fault-plane solutions then available and to draw inferences therefrom with regard to orogenetic processes. The results then obtained were published earlier (Scheidegger, 1957*a*).

New Evidence

Since the writer's earlier paper, some 300 new fault-plane solutions have appeared in the literature. The majority of these refer to very small ("local") earthquakes in central Asia that have been studied by various Russian groups in connection with the local tectonics of that area. A number of local central Asian earthquakes had already been included in the earlier investigation of the writer's, but it seems now hardly justifiable to use these small earthquakes in connection with a discussion of large-scale geotectonics.

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TABLE 1

FAULT-PLANE SOLUTIONS

(See text for explanation of lettered columns)

A	B	C	D	E	F	G	H	I
Nov. 16 1911 21:25	48 3 N 9 1 E	0 00	a″ b	S 36 E S 63 W	84 10	80 11	st dt	H57
June 26 1924	56 3 S 158 0 E	0.01	a″ b	S 40 W S 67 E	86 14	77 17	sp dp	Gi57
Jan. 15 1931 01:50:41	16 4 N 96 3 W	0 00	a b	N 3 W S 88 E	79 74	17 12	dp sp	M57
Nov. 13 1932 04:46:45	43 4 N 137 0 E	0 05	a b	S 8 W N 58 W	43 70	31 51	dp sp	M57
June 24 1933 21:54:38	5 0 S 104.2 E	0 00	a b	N 0 E S 54 E	70 35	62 41	sp dp	V57
June 29 1934 08:25:17	6 8 S 123 8 E	0 11	a″ b	S 82 W S 02 W	45 84	12 46	dp sp	R57
July 18 1934 01:36:29	8 2 N 86 2 W	0.00	a b	N 90 E N 11 W	63 84	13 29	dt st	M57
Sept. 11 1935 14:04:06	43.6 N 146 0 E	0 00	a b	N 63 E S 63 W	50 40	90 90	−p −p	M57
May 8 1936 09:11:34	5 8 S 112.8 E	0 09	a b″	N 18 E S 18 W	33 57	90 90	−t −t	R57
June 30 1936 15:06:44	51 0 N 161.1 E	0 00	a b	N 35 W S 35 E	66 24	90 90	−p −p	M57
Nov. 2 1936 20:45:56	38.3 N 141.9 E	0 00	a b	N 53 W S 53 E	15 75	90 90	−p −p	M57
Aug. 11 1937 00:55:22	6 5 S 116 5 E	0.09	a″ b	S 13 E N 11 E	24 68	68 80	dt st	R57
May 23 1938 07:18:28	36 5 N 141 6 E	0 00	a b	N 59 E S 59 W	84 6	90 90	−p −p	M57
Aug. 18 1938 09:30:04	3.8 S 102 8 E	0 01	a b″	N 30 W S 30 E	63 27	90 90	−p −p	R57
Oct. 20 1938 02:19:29	9.2 S 123 0 E	0 01	a″ b	N 84 E N 24 W	48 71	26 45	dt st	R57
Nov. 15 1938 21:00:16	4 8 S 98.8 E	0 00	a b	N 38 W N 52 E	80 90	0 10	d− s−	V57
Nov. 17 1938 03:54:34	55 6 N 157.7 W	0 00	a b	S 58 W S 43 E	68 68	24 24	sp dp	M57
June 18 1940 13:52:33	5 4 N 123 0 E	0 08	a″ b	N 45 W S 70 E	43 50	71 73	st dt	R57
Sept. 22 1940 22:51:58	7 5 N 123.5 E	0.10	a″ b	S 58 E S 55 W	38 73	28 55	st dt	R57
Jan. 31 1941 02:38:40	6.5 S 128.5 E	0.03	a″ b	N 12 W S 70 E	81 17	76 33	st dt	R57

TABLE 1—*Continued*

A	B	C	D	E	F	G	H	I
Sept. 17 1941	0 1 N	0.03	a″	N 90 W	66	33	dt	R57
06:48:04	122 7 E		b	S 15 E	60	28	st	
Nov. 27 1941	6 6 S	0.07	a″	N 43 W	73	57	sp	R57
08:37:34	121.1 E		b	S 23 W	37	29	dp	
Aug. 15 1947	44 0 N	0 00	a″	S 10 W	74	80	dt	K58
04:11	45 0 E		b	N 21 W	19	60	st	
Aug. 15 1947	44.0 N	0.00	a″	S 17 W	72	68	st	K58
04:58	45 0 E		b	N 36 W	28	41	dt	
Apr. 17 1948	33 0 N	0 00	a	S 47 E	86	90	−p	M57
16:11:05	135.5 E		b	N 47 W	4	90	−p	
Aug. 19 1948	61 0 N	0 01	a″	N 50 W	55	46	dp	G57
	152 5 W		b	N 65 E	50	42	sp	
Feb. 2 1949	50 5 N	0 03	a″	N 05 E	62	78	sp	G57
	173 5 W		b	S 30 W	30	68	dp	
Apr. 5 1949	41.0 N	0.08	a″	S 20 W	62	9	dt	G57
	132 5 E		b	S 75 E	82	28	st	
May 30 1949	16 5 N	0 08	a″	S 75 E	86	90	−t	G57
	146 0 E		b	N 75 W	4	90	−t	
Nov. 3 1949	48 5 N	0 02	a″	N 28 E	85	10	dp	G57
	156.0 E		b	S 65 E	80	6	sp	
May 17 1950	39.0 N	0.09	a″	S 78 E	24	90	−t	G57
	131 5 E		b	N 78 W	66	90	−t	
Aug 14 1950	27.0 S	0.10	a	N 30 E	82	13	s−	DM57
22:51:28	62.5 W		b	N 60 W	77	8	d−	
Oct. 25 1950	26 0 N	0 01	a″	N 65 E	78	65	sp	G57
	125.0 E		b	S 6 W	30	34	dp	
Dec. 10 1950	28 7 S	0.04	a	N 5 W	88	45	sp	M57
13:23:04	179 W		b	S 83 W	45	3	dp	
Dec. 12 1950	18 2 S	0.00	a	N 38 W	60	4	sp	M57
19:51:49	167 E		b	S 48 W	88	30	dp	
Jan. 5 1951	37.0 N	0 02	a″	N 80 W	30	90	−t	G57
	70 6 E		b	S 80 E	60	90	−t	
Jan. 6 1951	36 6 N	0 03	a″	N 35 W	32	22	sp	G57
	70.9 E		b	S 37 W	78	60	dp	
Aug. 13 1951	42.0 N	0 00	a″	N 20 W	80	14	dp	K58
18:58	33.0 E		b	N 73 E	76	10	sp	
Oct. 4 1951	36 6 N	0 03	a″	N 0 W	40	59	sp	G57
	70 5 E		b	S 40 W	54	66	dp	
Oct. 20 1951	43.0 N	0 00	a″	S 79 E	84	73	−p	K58
23:22	32 5 E				18		−p	
Oct. 21 1951	35 0 N	0 00	a″	S 78 E	84	73	−p	K58
00:14	46 0 E				18		−p	

TABLE 1—*Continued*

A	B	C	D	E	F	G	H	I
Oct. 21 1951 03:10	38 0 N 47 8 E	0.00	a″	S 21 E	52 44	66	−p −p	K58
Nov. 2 1951 21:55	43 0 N 45 7 E	0 00	a″	S 17 W	80 16	77	−t	K58
Dec. 12 1951 17:55	39 0 N 45 0 E	0 00	a″	S 12 E	34 61	60	−p −p	K58
Jan. 4 1952 15:01	40.1 N 59 0 E	0 00	a″	S 12 W	80 14	80	−p −p	K58
Feb. 11 1952 07:01:05	5 5 S 109 8 E	0 10	a″ b	N 86 W N 18 E	64 64	29 29	st dt	R57
Feb. 14 1952 03:38:15	7.7 S 126 5 E	0 00	a″ b	N 27 E N 54 W	87 74	37 9	dt st	R57
Mar. 19 1952 10:57:09	9.5 N 126.0 E	0.00	a″ b	N 48 E N 78 W	53 52	50 50	dt st	R57
Apr. 18 1952 05:26	39 0 N 45 0 E	0 00	a″ b	S 62 W	29 70	45	−p −p	K58
May 28 1952	37 0 N 70 8 E	0 03	a″ b	S 60 W S 55 E	20 82	26 72	sp dp	G57
July 5 1952	36 9 N 71 0 E	0.03	a″ b	N 46 E S 46 W	10 80	90 90	−p −p	G57
July 13 1952 17:34:30	3.1 S 127.4 E	0.00	a″ b	N 59 W N 73 E	26 72	45 71	dp sp	R57
Jan. 20 1953 17:33:07	1.5 N 126 E	0 00	a″ b	S 65 W N 25 W	80 89	1 10	sp dp	R57
Apr. 9 1953 00:36:16	7 3 S 131.0 E	0.00	a″ b	N 37 E N 68 W	59 67	27 34	dt st	R57
June 25 1953 10:44:57	8.5 S 123 5 E	0 00	a″ b	N 66 W N 24 E	87 88	2 3	dp sp	R57
July 7 1953 04:07:48	1 N 100 E	0.03	a″ b	S 40 E N 85 W	31 62	51 69	dp sp	R57
Nov. 13 1953 16:17:05	3 5 N 96 E	0 00	a″ b	S 72 E S 18 W	89 88	2 1	dp sp	R57
Dec. 2 1953 04:24:51	2 8 S 141 5 E	0.00	a″ b	N 50 W S 40 W	89 88	2 1	sp dp	R57
Dec. 7 1953 02:05:37	22 S 68.5 W	0 01	a b	N 24 E S 58 E	55 79	14 36	st dt	I57
Jan. 1 1954 13:04:19	9 0 S 123.5 E	0 01	a″ b	N 56 E S 23 E	64 89	11 28	dp sp	R57
Jan. 17 1954 17:39:38	16 5 S 36 E	0 00	a″ b	N 73 W N 24 E	68 74	17 23	dp sp	DeB56
Feb. 19 1954 19:07:48	30 S 177.7 W	0 00	a b	S 60 E N 30 E	87 80	10 3	sp dp	HC57

TABLE 1—*Continued*

A	B	C	D	E	F	G	H	I
Feb. 19 1954 21:34:41	12 5 N 87 5 W	0 00	a b	N 62 W N 35 E	55 82	11 36	st dt	HC57
Feb. 20 1954 18:35:07	6 9 S 124 5 E	0 09	a″ b	S 20 E S 89 W	28 80	21 64	sp dp	R57
Mar. 3 1954 06:02:55	5 5 S 142 5 E	0 00	a″ b	S 78 E N 11 E	76 85	5 15	dt st	R57
Apr. 17 1954 20:10:37	51 5 N 179 W	0 00	a b	N 2 W S 87 W	82 84	6 8	dt st	HC57
Apr. 27 1954 10:06:24	6 N 82 5 W	0 00	a b	S 84 E N 5 E	85 76	14 5	dt st	HC 57
Apr. 29 1954 10:49:27	28 5 N 113 W	0 00	a b	S 44 E N 45 E	88 68	22 2	sp dp	HC57
Apr. 30 1954 13:02:37	39 N 22 E	0 00	a b	N 4 W S 44 W	18 78	43 77	dt st	HC57
May 3 1954 15:29:40	51 5 N 159 5 E	0 00	a b	N 81 W N 16 E	70 71	20 21	st dt	HC57
May 14 1954 22:39:26	36 N 137 E	0 03	a b	N 34 W N 59 E	68 83	8 22	dp sp	HC57
June 6 1954 16:50:40	3 S 135.5 E	0 00	a″ b	N 64 E S 14 E	88 15	75 12	dt st	R57
July 3 1954 00:32:57	3 4 S 29.1 E	0 00	a″ b	S 81 E N 11 W	58 62	34 37	dt st	DeB56
July 3 1954 22:31:25	6 5 S 105.5 E	0.01	a″ b	S 37 W N 15 W	66 36	62 44	dp sp	R57
Aug. 18 1954 04:42:20	21 5 S 176 W	0.02	a b	S 63 E N 23 E	81 69	21 9	dt st	HC57
Sept. 13 1954 02:09:55	21 S 175 5 W	0.02	a b	S 73 E N 15 E	84 70	20 6	dt st	HC57
Sept. 15 1954 17:56:08	18 S 178 5 W	0.09	a b	N 38 W N 56 E	83 60	30 8	st dt	HC57
Sept. 20 1954 00:39:28	1 5 S 120 5 E	0.00	a″ b	N 35 W N 74 E	38 76	23 54	dp sp	R57
Oct. 3 1954 11:18:46	60 5 N 151 W	0 01	a b	S 54 E S 44 W	52 77	15 39	st dt	HC57
Oct. 3 1954 23:21:35	1 5 S 127.5 E	0 00	a″ b	N 21 E N 70 W	87 80	10 32	sp dp	R57
Nov. 2 1954 08:24:10	8 0 S 119 0 E	0 00	a″ b	N 89 W N 2 E	87 74	16 3	dt st	R57
Dec. 16 1954 11:07:11	39 3 N 118.1 W	0.00	a b	N 79 E N 25 W	62 66	28 31	dt st	Ro57
Jan. 5 1955 17:48:35	16 S 167.5 E	0.00	a b	S 34 E N 56 E	56 89	1 34	dt st	HC57

TABLE 1—*Continued*

A	B	C	D	E	F	G	H	I
Jan. 13 1955 02:03:43	53 N 167 5 W	0 00	a b	S 38 E N 51 E	89 74	16 2	sp dp	HC57
Mar. 14 1955 13:12:04	52 5 N 173 5 W	0 01	a b	N 71 W N 23 E	70 79	12 20	st dt	HC57
Apr. 17 1955 18:35:27	52 N 159 2 E	0 00	a b	N 39 W N 52 E	84 78	12 6	st dt	HC57
Apr. 19 1955 20:24:05	30 S 72 W	0 00	a b	N 55 W N 41 E	72 72	19 19	st dt	HC57
May 30 1955 12:31:41	24 5 N 142 5 E	0 09	a b	N 20 W S 70 W	35 90	0 55	dt st	HC57
June 20 1955 12:07:25	51 5 N 180	0 00	a b	N 52 W N 63 E	58 56	41 40	st dt	HC57
July 16 1955 07:07:08	37 5 N 27 E	0 00	a b	N 50 W N 40 E	84 84	6 6	dp sp	HC57
Aug. 16 1955 11:46:58	6 S 155 E	0 03	a b	N 41 W N 52 E	81 71	19 9	dp sp	HS58
Aug. 21 1955 17:33:58	3 S 137 5 E	0.00	a b	S 16 E N 64 E	60 72	21 31	sp dp	HS58
Aug. 28 1955 20:13:30	14 N 91 W	0 01	a b	S 83 E N 5 W	73 54	38 21	sp dp	HS58
Sept. 12 1955 06:09:20	32 5 N 30 E	0 00	a b	N 57 W N 52 E	64 56	39 32	dp sp	HS58
Nov. 22 1955 03:24:00	24 5 S 123 W	0 00	a b	N 88 W N 02 E	89 79	11 1	dp sp	HS58
Jan. 8 1956 20:54:13	19 S 70 W	0 00	a b	N 72 W N 21 E	83 67	23 8	st dt	HS58
Jan. 10 1956 08:52:36	25 S 176 W	0 00	a b	S 65 E N 23 E	82 79	11 8	dt st	HS58
Feb. 9 1956 14:32:40	31 5 N 116 W	0 00	a b	S 71 E N 18 E	85 72	18 5	sp dp	HS58
Feb. 18 1956 07:34:16	30 N 137 5 E	0 07	a b	S 61 E N 14 E	56 68	27 37	dt st	HS58
July 9 1956 03:11:39	37 N 26 E	0 00	a b	N 47 W S 28 W	72 55	37 22	dt st	HS58
July 9 1956 09:56:13	20 N 73 W	0 01	a b	S 77 E N 8 E	64 79	12 27	sp dp	HS58

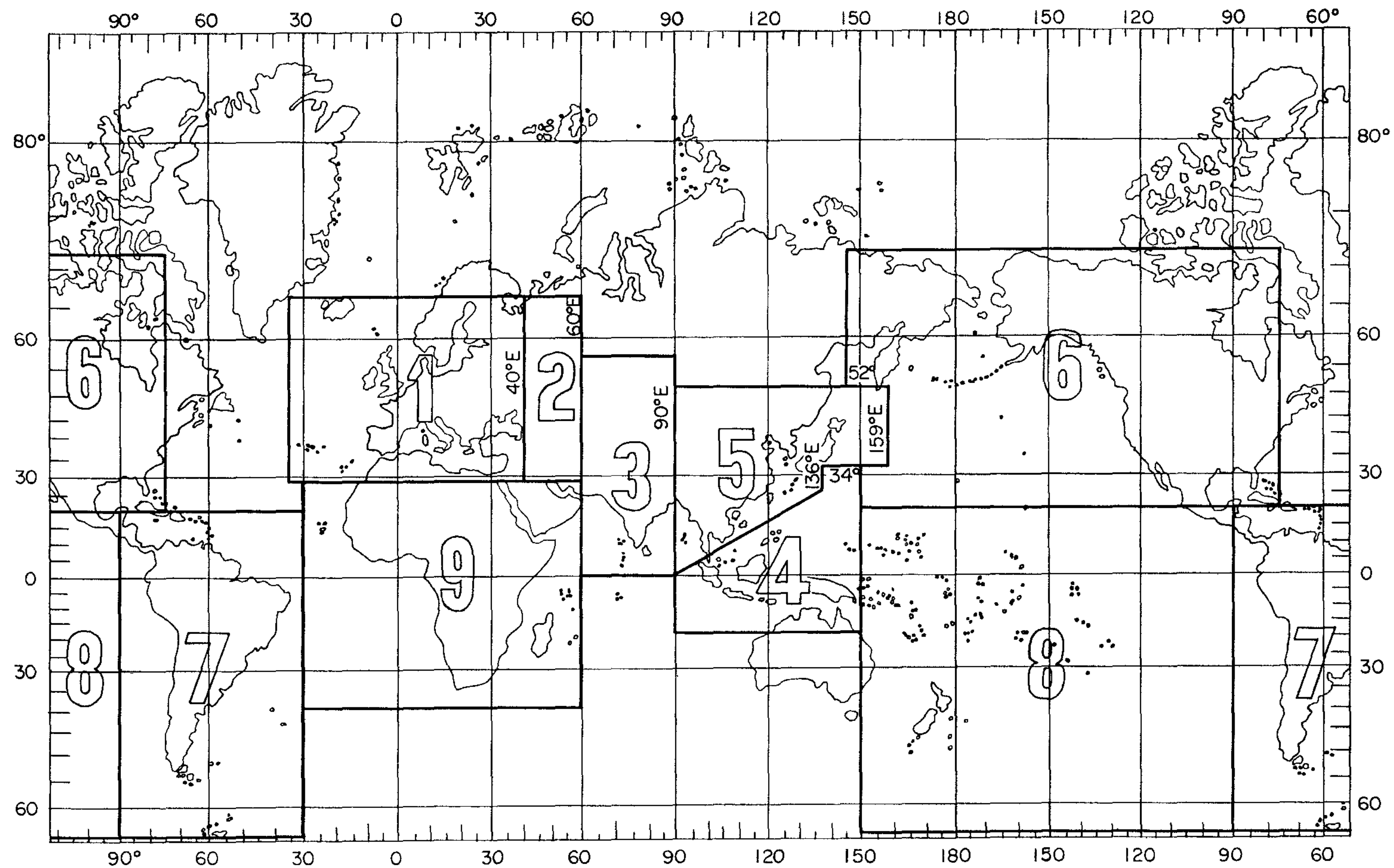

Fig. 1. Nine earthquake areas of the world.

It has therefore been decided to recalculate the earlier tables of averages, using only "teleseisms." If this be done, only 164 of the earthquakes previously collected by the writer (Scheidegger, 1955, 1957*a*, 1957*b*) are usable. To these are now added 101 new fault-plane solutions (to make a total of 265), extracted from a variety of recent references. As in our earlier work, these solutions have been tabulated in a standard fashion and are shown in table 1. Thus, we list the date and time (column A) and the location of the epicenters (column B) of the shocks as given by the individual authors, the depth in 0.0n R (column C), and the two planes, one of which represents the fault plane, the other the auxiliary plane. These two planes are given by their dip (column F) and dip direction (column E). If it be known which of the two planes represents the fault plane, that solution is marked by two primes (column D). Finally, the "slip angle," i.e., the angle between the strike direction of the fault plane and the direction of the motion axis, has been calculated for each fault-plane solution (column G). The character of the fault is shown in column H (s for sinistral, d for dextral, t for tensional, p for compressional) and the literature reference is given in column I.

Statistical Analysis

As in our earlier papers, the world has been dissected into large earthquake areas, of which there are now nine (see fig. 1). With regard to these areas various averages have been calculated from the fault-plane solutions, in conformity with the earlier procedures. For the statistical averages each earthquake has been given double weight, so that if it was not clear which was the fault plane and which the auxiliary plane, both possibilities could be counted. If it was known which was the fault plane, then only that solution has been used, but then it has been given double weight.

The result of the calculations is shown in tables 2 to 6. Earlier findings are thereby corroborated, which means (i) that, in the majority of cases, earthquake faulting is predominantly transcurrent; and (ii) that there are exceptions to the general transcurrency of faulting in the areas 2 (Caspian Sea), 3 (Pamir Knot and Hindu Kush), and possibly 4 (Indonesia).

However, the number of fault-plane solutions has now so much increased that it becomes possible to draw further inferences. It is feasible to make a breakdown with regard to depth (see table 3). If this be done, a very peculiar situation occurs at 0.03 R: it is seen that the ratio of the number of tension to pressure earthquakes as well as the ratio of the number of strike slip to dip slip earthquakes becomes a minimum. The slip angle, consequently, has a maximum at that depth. This is very peculiar, but it is perhaps too early to attach too much significance to the observation. A check of the earthquakes reveals that a good number of them (17) happen to lie in the areas 3 and 4 which are known to be exceptional. Thus we may be faced with a regional peculiarity rather than with one that is conditioned by the depth.

Another investigation that might be of interest is one with regard to the effect of depth in the various areas. In conformity with the idea that there might be an orogenetic decoupling layer at 140 km. depth (Gutenberg, 1955; Press, 1959), we term the earthquakes up to and including a depth of 0.02 R as "shallow," the others as "deep." This is not in conformity with the common usage of the words, but it seems to be adequate for orogenetic considerations.

TABLE 2

ALL EARTHQUAKES

Region	No. of earthquakes	Per cent			Ratio ten. to pres.	Per cent			Ratio st sl to dip sl.	Avg slip angle
		Pres.	Ten.	Ind.		Strike slip	Dip slip	Ind.		
1	17	17.6	52.9	29.4	3.000	88.2	11.8	0.0	7.500	23
2	12	58.3	41.7	0 0	0.714	12 5	87.5	0.0	0.143	67
3	14	64.3	28.6	7.1	0.444	28.6	60.7	10.7	0.470	64
4	59	40.7	45.8	13.6	1.125	47.4	50.8	1.7	0.933	45
5	73	27.4	16.4	56 2	0 600	75 3	22.6	2.1	3.333	26
6	32	40.6	59.4	0 0	1.462	76.6	21 9	1.6	3 500	30
7	13	23.1	53.8	23.1	2 333	92.3	3 8	3.8	24.000	19
8	43	65 1	25.6	9.3	0.393	94 1	3.5	2 3	27 000	14
9	2	50.0	50.0	0 0	1 000	100.0	0.0	0 0	∞	26
World	265	40.8	35.8	23.4	0.880	68.8	28.9	2.3	2 386	32

TABLE 3

DISTRIBUTION WITH DEPTH

Depth	No of earthquakes	Per cent			Ratio ten. to pres	Per cent			Ratio st. sl. to dip sl.	Avg. slip angle
		Pres.	Ten.	Ind.		Strike slip	Dip slip	Ind		
0.00 R	143	37.7	37.7	24 5	1.000	78 7	20.6	0.7	3.814	25
0.01 R	27	55 6	22 2	22 2	0 400	63.0	31 5	5.6	2.000	35
0.02 R	9	44 4	44.4	11 1	1.000	66 7	33 3	0.0	2.000	38
0.03 R	26	61.5	27 0	11.5	0.438	34.6	55 8	9.6	0.621	55
0.04 R	6	50 0	33.3	16 7	0 667	91.7	8 3	0.0	11 000	21
0.05 R	20	35 0	20 0	45 0	0.571	62.5	32 5	5.0	1 923	39
0.06 R	4	25 0	25.0	50.0	1 000	50 0	50 0	0.0	1 000	36
0.07 R	7	28.6	57.1	14 3	2.000	57 1	42.9	0.0	1.333	45
0.08 R	7	28 6	71 4	0 0	2.500	50.0	50 0	0.0	1.000	50
0.09 R	10	20 0	60.0	20 0	3 000	60.0	40.0	0.0	1.500	37
0.10 R	6	33 3	50.0	16.7	1.500	75.0	25.0	0.0	3.000	31

TABLE 4

SHALLOW EARTHQUAKES

Region	No. of earthquakes	Per cent			Ratio ten. to pres.	Per cent			Ratio st. sl. to dip sl.	Avg slip angle
		Pres.	Ten.	Ind.		Strike slip	Dip slip	Ind.		
1	16	12.5	56.2	31.2	4 500	90.6	9.4	0 0	9 667	22
2	12	58 3	41.7	0.0	0.714	12.5	87.5	0 0	0 143	67
3	5	20.0	60.0	20.0	3.000	40 0	50 0	10.0	0.800	55
4	25	60.0	36.0	4 0	0 600	66 0	34.0	0.0	1.941	32
5	46	23.9	6 5	69.6	0.273	76 1	21.7	2 2	3 500	22
6	31	38 7	61 3	0 0	1 583	79 0	19 4	1 6	4.083	29
7	11	27.3	63 6	9 1	2 333	90 9	4 5	4.5	20.000	21
8	31	67.7	25 8	6 4	0 381	95 2	4 8	0 0	19 667	15
9	2	50 0	50 0	0.0	1.000	100.0	0 0	0.0	∞	26
World	179	40 8	35.8	23.5	0 877	75 7	22 9	1.4	3.305	27

TABLE 5

DEEP EARTHQUAKES

Region	No of earthquakes	Per cent			Ratio ten. to pres	Per cent			Ratio st sl to dip sl.	Avg slip angle
		Pres.	Ten.	Ind		Strike slip	Dip slip	Ind		
1	1	100 0	0.0	0 0	0 000	50 0	50 0	0 0	1 000	44
2	.	. .					.		.	.
3	9	88.9	11 1	0 0	0 125	22 2	66 7	11.1	0.333	70
4	34	26 5	52 9	20 6	2 000	33 8	63 2	2 9	0 535	55
5	27	33 3	33 3	33 3	1 000	74 1	24 1	1 8	3.077	40
6	1	100 0	0 0	0 0	0.000	0 0	100 0	0 0	0.000	78
7	2	0 0	0 0	100 0	....	100 0	0 0	0 0	∞	5
8	12	58.3	25 0	16 7	0 428	91 7	0.0	8 3	∞	12
9	.		. .	.		.	.		....	.
World	86	40 7	36.0	23.2	0 866	54 6	41 3	4.1	1 324	43

TABLE 6

COMPARISON OF DEEP AND SHALLOW EARTHQUAKES

Region	Ratio of tension to pressure		Ratio of strike slip to dip slip		Slip angle	
	Deep	Shallow	Deep	Shallow	Deep	Shallow
3.	0 125	3.000	0.333	0 800	70	55
4	2 000	0 600	0.535	1.941	55	32
5.	1 000	0 273	3 077	3 500	40	22
8.............. . . .	0 428	0.381	∞	19.667	12	15
World	0 886	0 877	1 324	3 305	43	27

The result of this investigation is shown in tables 4 and 5. A more direct collation of the results has been attempted in table 6. It is only in regions 3, 4, 5, and 8 that a proper comparison can be made, since only there do we have enough deep-focus earthquakes (in the sense used above) to permit our obtaining any significant results. An inspection of the last table (table 6) shows that there is a pretty good correlation[1] between the results from the "deep" and "shallow" earthquakes in any one area, as well as in the world as a whole. This seems to indicate that whatever it is that causes earthquakes acts in a similar fashion at small and at great depths. At any rate, there does not seem to be a definite break in the failure pattern at some intermediate depth. Unfortunately, the number of fault-plane solutions is still far too small to permit our making an analysis in terms of smaller depth steps (say: 0.01 R) for all the nine earthquake areas under consideration.

CONCLUSION

Reviewing the work reported above, it is seen that a statistical analysis of fault-plane solutions provides a means for a discussion of geotectonics. Each individual fault-plane solution has little significance by itself, since the characteristics of the

[1] The dip-slip components are somewhat erratic; the strike-slip components run exactly parallel in all areas, although they are, on the whole, somewhat smaller in shallow earthquakes.

fault in any single earthquake seem due mostly to chance. However, averages that can be calculated for earthquake regions have a connection with the prevailing stress system. The various results obtained above will therefore have to be taken into account in any discussion of geotectonics.

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[Symbols used in column I of table 1 are given in square brackets.]

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California Institute of Technology,
Pasadena, California.
(Division of Geological Sciences, contribution no. 926.)